



UNITED STATES MARINE CORPS

COMMANDER, MARINE FORCES RESERVE
4400 DAUPHINE STREET
NEW ORLEANS, LOUISIANA 70146-5400

ORIGINAL

ForO 5100.12

BOS

16 NOV 1995

FORCE ORDER 5100.12

From: Commander
To: Distribution List

Subj: SAFE HANDLING OF LITHIUM SULFUR DIOXIDE BATTERIES LiSO_2

Ref: (a) TI 6135-15/3
(b) 29 CFR 1910.1200
(c) TB 43-0130
(d) TB 43-0134
(e) DRMS-M 6050.1
(f) 49 CFR SUB CHAPTER C (In volume w/parts 100-177)
(g) 40 CFR PARTS 260-299

Encl: (1) General Information
(2) Glossary of Terms

1. Purpose. To promulgate Marine Forces Reserve (MARFORRES) policy concerning the safe use, transportation, handling, storage, and disposal of lithium sulfur dioxide batteries LiSO_2 (also known as Lithium Batteries BA-5XXX/U and BA-6XXX/U). It is intended to clarify, not to replace federal, or state fire or environmental regulations.

2. Cancellation. ForO 5100.7.

3. Background

a. Past incidents have occurred involving lithium-sulphur dioxide batteries resulting in venting, heating, leakage, or rupture. These situations were usually a result of cell shorting, abusive uses, uninsulated wires, or corrosion at the glass-to-metal seals. Improvements in cell design, including a balanced cell and a glass-to-metal seal with structural integrity, adherence to use limitations, and the incorporation of safety devices such as diodes, thermal sensors, and fuses have significantly reduced the occurrence of incidents.

b. References (a) through (g) are the basic directives used in the establishment of MARFORRES's policy concerning lithium sulfur dioxide batteries.

c. General information, enclosure (1), is provided as guidance for the safe management of lithium batteries. Enclosure (2), the Glossary of Terms, is given to help explain unfamiliar words, acronyms and terms used in enclosure (1).

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4. Information. Lithium-sulfur dioxide batteries should be considered potentially hazardous at all times, especially under conditions of abuse, misuse, depletion, or partial discharge. Incidents have been documented involving rupturing and the venting of toxic gases.

5. Action. Unit Commanders will:

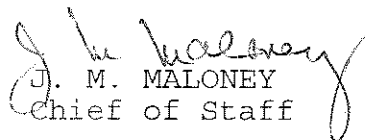
a. Comply with the provisions of this Order regarding the storage, use, transportation and disposal of lithium batteries.

b. Ensure that all personnel who work with or handle lithium batteries are made aware of the safety provisions for the safe handling and disposal of lithium batteries.

c. Ensure that personnel are indoctrinated in the Hazardous Communication Program and review the Material Safety Data Sheet before working with lithium batteries, reference (b) applies.

6. Mobilization. Paragraph 10 of enclosure (1) dealing with transportation, is particularly pertinent to mobilization planning and should be immediately reviewed if mobilization seems imminent.

7. Reserve Applicability. This Order is applicable to the Marine Corps Reserve.


J. M. MALONEY
Chief of Staff

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GENERAL INFORMATION

1. Scope. The highly energetic nature of lithium batteries requires that safeguards be employed. Lithium batteries are to be considered hazardous at all times and especially under conditions of abuse. Each cell contains lithium metal (a flammable metal), sulfur dioxide or other noxious gases and organic or inorganic solvents under pressure.

2. Personnel who use or handle lithium batteries should be aware of the different types and classes of batteries. For reference (a), the following batteries are used as the main power sources in Marine Corps communication equipment:

<u>Battery Class</u>	<u>Type/Number</u>
a. Lithium - Manganese Dioxide (Li-MnO ₂)	BA-5372/U & BA-5516/U
b. Lithium - Sulfur Dioxide (Li-SO ₂)	BA-5567
c. Lithium - Sulfur Dioxide (Li-SO ₂)	BA-500 Series (except BA-5372/U, BA-5516/U & BA-5557/U)
d. Lithium-Thionyl Chloride (Li-SCOC1 ₂)	BA-6000 Series

3. Safety Features

a. The most commonly used lithium battery is the BA-5590/U. This battery consists of 10 sealed cells. It is protected by a 2.5 ampere slow blow replaceable fuse in each of its two 12 volt sections. Each cell is designed with a venting device which releases internal cell pressure to ambient pressure if the internal pressure exceeds 350-450 psi.

b. Lithium battery BA-5598/U (most commonly used in the AN/PRC-77 radio set), consists of 5 cells which are protected by a fuse. Each cell has a venting device to release internal pressure.

c. The fuses are to protect against excess currents caused by external short circuits which could lead to overheating, cell venting or cell rupture. The fuses shall not be bypassed nor replaced with a higher rated fuse.

d. The venting device will engage when internal pressures become excessive due to cells overheating. This venting serves to prevent the cells from rupturing. If a cell vents, poisonous

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gases such as sulfur dioxide, methyl cyanide, or other noxious cathode gases will be released. These gases are serious eye and respiratory irritants. Irritation will occur long before toxic concentrations are reached and serves as a warning. Seek qualified medical assistance if eye or respiratory irritation occurs. Lithium batteries contain no radioactive material.

4. Handling. Per reference (a), the Material Safety Data Sheet (MSDS) shall be reviewed before handling lithium batteries. Lithium batteries are to be considered hazardous at all times. Per references (a), (b) and (c), the following safety precautions shall be observed when handling the batteries:

a. Full face shield, eye goggles, apron and gloves impermeable to the lithium mixture (type used in the lead acid battery shop) shall be worn by personnel handling leaking cells. The leaking cells shall be placed in a plastic bag and removed to an appropriate disposal area.

b. Due to the pressurized cells within a lithium battery, under no circumstances shall a battery be deliberately opened, crushed, punctured, disassembled, or otherwise mutilated.

c. Lithium batteries shall not be heated or incinerated, as overheating may produce internal pressure at a rate in excess of venting capacity and could result in a cell or battery rupturing.

d. Under no condition shall a lithium battery be recharged, as such action may lead to venting poisonous gases, rupturing, or possibly a fire.

e. Keep lithium batteries in original protective packing until ready for use. Once the plastic cover is removed/opened the battery is considered used.

f. In order to avoid catastrophic rupture, ensure that the vent device is not plugged and that gas products can be dissipated.

g. Batteries shall be packaged so that there is sufficient and proper insulation between cells and leads to avoid the cell-to-cell contact and shorting.

5. Use. Per references (a) and (d), the following safeguards shall be exercised when using lithium batteries:

a. Batteries manufactured prior to September, 1980 shall not be used by Marine Corps personnel.

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b. Lithium batteries manufactured prior to November, 1984 shall not be used by Marine Corps personnel in the parallel mode.

c. Do not use batteries in the parallel mode without diode protection in either the lithium battery or equipment (see reference (a)).

d. On equipment using batteries in parallel, when one battery is depleted, replace the other battery(ies).

e. Use lithium batteries in authorized equipment only. Improper use may result in injury to personnel or damage to the battery and equipment.

f. When equipment will not be used within 12 hours, remove lithium batteries from equipment, as leaks can occur after de-energizing equipment.

g. If there is a power source induced delay exceeding two minutes when the equipment is turned on or during its operation, the lithium batteries may be weak or malfunctioning and should be replaced.

h. Avoid bridging (shorting) the case (anode) to the center post (cathode) with either a metal tool, equipment chassis, or another cell casing. Arching at the anode can generate sufficient instantaneous heat to initiate battery venting, or at a minimum, cause reduced service life of the cell. This situation can be avoided by keeping individual cells separated to avoid cell-to-cell contact.

6. Operator Immediate Action. In the event that an equipment operator detects the battery compartment becoming unduly hot, hears cell venting (hissing sound), or smells the irritating sulfur dioxide gas, the operator should immediately do the following, reference (c) pertains:

a. Turn off the equipment. Quickly clear the area of other personnel. Notify your safety manager of the situation.

b. After allowing sufficient time (one to four hours) for the battery to cool, then remove the battery.

c. Dispose of the battery in accordance with enclosure (1), paragraph 9f of this Order.

7. Storage. The requirements set forth in this section are intended for user storage areas and containers, references (a) and (c) pertain. Approval for the lithium battery storage area/container should be obtained from the local fire department.

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Unless directed otherwise by the local fire department, lithium batteries shall be stored in the following manner:

a. Lithium batteries are authorized to be stored inside work spaces only in authorized containers and in well ventilated areas. The container shall be labeled "Flammable Solid Lithium Batteries." A minimum of a two-foot clearance shall be maintained between the container and any fire door opening. A vertical clearance of three feet shall be maintained between the top of the container and sprinkler heads. In facilities without sprinklers, a three-foot clearance shall be maintained between the top of the container and the ceiling or roof construction.

b. Outside storage in a general shed or in ventilated lockers in a limited access area is also authorized, if the batteries are not subject to temperatures exceeding 130 degrees Fahrenheit.

c. Lithium batteries shall be stored in their original shipping containers in a cool, sprinkler protected (if available), ventilated shelter. If original shipping containers are not available, storage containers should be of plastic, metal, or wood construction that affords protection from damage. Individual cells and batteries shall be sealed in plastic.

d. Lithium batteries shall be stored by themselves in the container.

e. Smoking and eating shall be strictly prohibited in cell/battery storage locations. "No Smoking" signs will be posted in all storage areas.

f. Do not refrigerate, due to the possibility of a reaction caused by moisture from condensation.

g. All areas where lithium batteries are stored or used shall be equipped with a class "D" fire extinguisher, e.g., NSN 4210-01-303-3999 or equivalent, such as Lith-X-type.

h. Storage areas shall be located away from personnel or vehicular traffic ways.

8. Fire Protection. The lithium metal present in lithium batteries is similar to phosphorous and will burn when exposed to air. The fire cannot be extinguished with water, if the quantity of lithium exposed is significant; i.e., if many cells are vented and opened, references (a), (b) and (d) pertain.

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a. A fine spray of water in sufficient amounts so as to "flood" the burning materials may be useful. Fine spraying will tend to cut off air access to the fire and will cool down the batteries so that further cell venting and burning are minimized. Sprinkler systems are approved for areas where lithium batteries are stored and used. Should a fire involving lithium batteries generate sufficient heat to activate a sprinkler system, the best course of action is to let the lithium involved expend itself and allow the sprinklers to "flood" the surrounding area. Efforts should be aimed at preventing the spread of the fire to other combustibles. Check with your local fire department.

b. An extinguisher such as Met-L-X or Lith-X-type (Class D) will extinguish burning lithium. Carbon dioxide and dry chemical extinguishers have been found to be ineffective in such fires and may in fact, compound the problem. Special instructions on the use of Class D extinguishers are required as the operating techniques differ from those associated with other types of extinguishers. "Hands on" instruction is necessary. Halon extinguishers shall not be used. Halon and lithium, when mixed, produce toxic fumes.

9. Disposal

a. For reserve centers which are located on large bases that turn-over their lithium batteries (and other Hazardous Waste (HW)) to the base, and comply with that base's disposal requirement, the remainder of paragraph 9 does not apply.

b. Reserve centers which are not located on large bases and dispose of their lithium batteries directly to municipal trash collectors, vendors or Defense Reutilization and Marketing Service (DRMO's) shall comply as follows, references (d), (e) and (g) pertain.

c. All but five states allow disposal of completely discharged Lithium-Manganese Dioxide batteries in municipal trash. At present Alaska, California, Minnesota, Rhode Island and Washington consider some types of lithium batteries as HW. The unit shall confirm the disposal method with their DRMO, or with whomever collects their trash before disposing of the batteries.

d. Lithium batteries manufactured prior to October 1981 are hazardous waste in all states and should be identified to the DRMO as "unbalanced."

e. Lithium batteries manufactured since 1981 include in their configuration a Complete Discharge Device (CDD). The device is a switch which will completely discharge the battery. The using unit must insure activation of the device after use and prior to disposal.

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DRMO or their contractor will not activate the CDD. Advise the municipal trash collector that the batteries have been completely discharged prior to disposal. Completion of discharge takes 5 days:

f. The disposal cycle begins immediately on return of the depleted battery to a temporary collection point, such as the tailgate of a truck. Cover the battery's terminals with electricians tape to prevent short circuits. Place the battery in a shipping box for return to the home training center. Prohibit passengers in the truck from handling depleted batteries during the return trip. Account for all lithium batteries. The number issued as new shall equal the number returned as depleted.

g. At the Home Training Center (HTC), activate the CDD to begin a 5-day monitoring period. During this period, monitor the batteries for overheating or venting. The batteries must be in a well ventilated open area at least 2 inches from each other. Do not stack tightly or place in a container. Do not puncture the case.

h. If after 5 days a battery still shows signs of overheating, such as too hot to hold, a melted plastic case, or a vented cell, it cannot be certified as "completely discharged". Lithium batteries which have overheated during the CDD cycle may not have completely discharged, and all such batteries are considered HW. Lithium batteries which are leaking a liquid or a gas are also considered a Hazardous Waste and shall be disposed accordingly.

i. Allow overheated batteries to cool. Leaking batteries should leak until the pressure is relieved and the leaking has stopped or nearly stopped. Replace the battery into its plastic wrap and carton. Place the battery into a larger sealable container or a plastic bag with vermiculite adsorbent compound. Add three times as much vermiculite as the volume of each battery. Seal the bag or container to prevent the liquid in the battery from spilling.

j. The Department of Transportation (DOT) has the following specifications for containers that carry lithium batteries, see reference (f):

Steel Drum 1A2 or 1B2
Fiber Drum 1G

Plywood Box 4D or 4F
Fiber Board Box 4G

A note on the outside of the box must certify the DOT number. Do not obscure this certification with labels or other stick-ons.

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k. Environmental Protection Agency (EPA) regulations provide for "satellite" accumulation points, where HW can be stored without time limit until a volume of 55 gallons (7.35 cubic feet) is reached. On the day the container reaches 55 gallons, that date must be marked on the container. This date is the beginning of the accumulation time prior to disposal. Generators are allowed a storage time of 90 days (for fully regulated) or 180 days for small quantity generators who have an established emergency plan. There may be more than one container at the accumulation point. If there is more than one container, they must be set in close proximity and under the control of one person, references (b) and (g) pertain.

l. After the 5-day period, rewrap the batteries in the plastic bag, and replace the batteries in their shipping carton. For batteries which can go into a municipal land fill, route those batteries to that end. For batteries which are HW, put them in the carton in which they were shipped to you.

m. The DRMO has a number of requirements for accepting non-leaking lithium batteries for disposal, including but not limited to:

(1) CDD must be activated and battery completely discharged.

(2) Battery terminals must be protected from shorting, and covered with tape. Additional DRMO requirements may be levied.

(3) Hazardous Waste Profile Sheet for each type of battery included with the DD 1348-1.

(4) A note on the DD 1348-1 that the batteries are "balanced cell batteries" (manufactured after 1981) and that "CDD activated" must be attached.

10. Transportation. All transportation of lithium batteries on public highways is controlled by Federal law regulating shipment of hazardous material. Per references (e), (f) and (g) the following steps shall be taken when managing the transportation of batteries:

a. Transport replacement batteries to the drill site in the box in which they were shipped to you.

b. Transport the batteries from the drill site, wrapped in plastic and in the cardboard box in which they were shipped to you. Mark the box on one side with the following markings:

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CLASS 9
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EPA CHARACTERISTIC D003

Fill voids between the cartons and the shipping box with vermiculite. Apply tape over the top of the box. Secure the box to the vehicle.

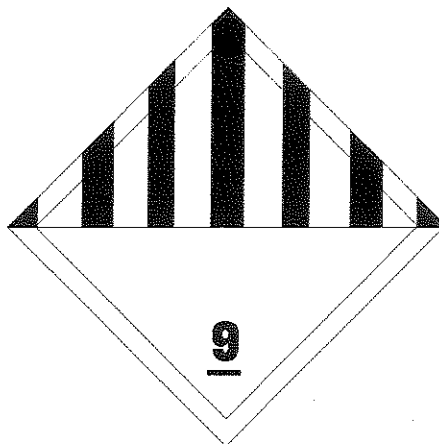
c. After returning to the Home Training Center (HTC), reopen the batteries and activate the CDD as in enclosure (1) paragraph 9g.

d. If the batteries must be disposed of as HW, apply the hazardous waste marking to each package. The marking reads as follows: - - - - -
- "HAZARDOUS WASTE - Federal Law Prohibits Improper Disposal. If found, contact the nearest police or public safety authority or the U.S. Environmental Protection Agency."

Generator's Name and Address _____
Manifest Document Number _____
- - - - -

e. In the 49 CFR, lithium batteries are classified as CLASS 9 and placarding the transporting vehicle is NOT required if the shipping package is labeled.

f. Except for size and color, the "CLASS 9" (miscellaneous hazardous materials) label must be as follows:



g. The background on the CLASS 9 label must be white with seven black vertical stripes on the top half. The black vertical

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stripes must be spaced, so that, visually, they appear equal in width to the six white spaces between them. The lower half of the label must be white with the class number "9" underlined and centered at the bottom. Labels are available in standard form from the General Services Administration (GSA) and safety equipment vendors.

h. The shipment of batteries and their disposal must be accompanied by a number of documents in a HW manifest folder in this Order:

- (1) The DD 1348-1, or
- (2) The Hazardous Waste Manifest EPA form 8700-22, or
- (3) The state's shipping form if required, or
- (4) Any kind of transfer document.
- (5) Hazardous Waste Profile Sheet (DRMS Form 1930).
- (6) An emergency plan, in case of vehicle accident or spill of battery contents, including an MSDS for the batteries and a list of telephone contacts.
- (7) The front of the folder shall be titled in large contrasting letters, "HAZARDOUS WASTE MANIFEST."

i. The driver of a motor vehicle containing hazardous material, shall ensure that the HW manifest folder required by this section is readily available to, and recognizable by, authorities in the event of an accident or inspection. Specifically, the driver and the carrier shall:

(1) Clearly distinguish the HW manifest folder, by having it appear first; and

(2) Store the HW manifest folder as follows:

(a) When the driver is at the vehicle's controls, the HW manifest folder shall be within his immediate reach while he is restrained by the lap belt and either readily visible to a person entering the driver's compartment or in a holder which is mounted to the inside of the door on the driver's side of the vehicle.

(b) When the driver is not at the vehicle's controls, the HW manifest folder shall be in a holder which is mounted to the inside of the door on the driver's side of the vehicle or on the driver's seat in the vehicle.

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j. The driver shall possess a valid Government Drivers License.

11. Aircraft. The transportation of lithium batteries aboard aircraft including military aircraft, is governed by DOT regulations and MCO P4030.19/AFR 71-4, reference (a) pertains.

a. Routine air transportation of new lithium batteries may be by commercial or military aircraft provided:

(1) The aircraft is designated for cargo only.

(2) Original packaging or repacking in accordance with DOT regulations is utilized.

b. Tactical or contingency air transportation of new batteries is governed by Chapter 3 of MCO P4030.19D which specifies requirements.

(1) Specifying hazardous cargo applicability in the aircraft request.

(2) Approval from the aircraft commander prior to loading the cargo or equipment containing lithium batteries.

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GLOSSARY OF TERMS

Balanced Cell - A battery cell so designed, that during discharge, its reactive constituents (i.e., anode and cathode) are depleted in a quantitatively even manner.

Battery - A portable power supply unit made up of one or more cells with all necessary connectors, fusing, wiring, and jacket to provide power to an end article application.

CDD - Complete Discharge Device. A switch to completely discharge a battery.

Cell - The smallest power producing unit of a battery.

Damaged - A cell or battery which is broken, bulged, cracked, split, etc., to the degree that one or more cells or the case have lost physical integrity and the cell contents may leak, or have leaked out.

Defective - Any battery other than depleted, which will not operate its assigned equipment, provided the equipment is not responsible for this lack of operation.

Depleted - Any battery which has been used to the end of its duty cycle (e.g., to its cut-off or end of life voltage).

Disposal - Burying, crushing, destroying, burning, incinerating, or discarding into the general refuse/trash.

Disposition - The transfer of unserviceable battery(ies) or the local servicing DRMO for disposal.

Generator - Facility who decides that hazardous material no longer has any use where upon, it instantly becomes a hazardous waste.

Hazardous Material - A substance or material containing a substance, which has been determined by the Secretary of Transportation to be capable of health, safety, and/or hazardous property when transported in commerce, and which has been so designated.

Hazardous Waste - Hazardous Material which you no longer have a use for and is not going to be recycled. A waste that is listed or exhibits any type of the characteristics as defined per existing federal (i.e., Title 40 CFR, Part 261, Subpart C or D), state or local regulations.

Labeling - Are warning labels very similar in shape, color, and design to placards that are put directly on packaging containing hazardous materials. All labels are color-coded for quick recognition of the existing hazard.

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Marking - Markings generally use words and numbers to communicate their message. This will include the proper shipping name and the UN or NA. The information on a package identifying the contents.

Non-hazardous Solid Waste - A solid waste which is not a hazardous waste.

Placard - A warning notice. Placards alert emergency response personnel to the potential dangers associated with the hazardous materials carried in trucks etc. It is a 12 1/2 inch square sign placed on a vehicle traveling on a public highway.

Primary Battery - A non-rechargeable battery.

Recycled Material - Material that is reutilized, instead of being disposed of as waste. Per federal and state regulations materials may be recycled, thereby removing potentially hazardous material from the waste stream so that it may be reused. The process is regulated under Title 40 CFR Part 264, 265, 266, 268 and 270.

Resource Conservation and Recovery Act - Federal law, enacted under Title 40, Code of Federal Regulations, which protects the environment by regulating the disposal and recycling of potentially hazardous wastes.

Sealed Battery - A battery without vent/filler caps.

Secondary Battery - A battery which can be used for its original intended purpose.

Solid Waste - A material which is normally considered as trash, refuse or garbage, which is not a waste defined as a hazardous waste. It may be solid or liquid.

Spent - See "depleted."

Unserviceable Battery - A battery which is damaged, defective, depleted, spent, or has exceeded its shelf life.

Waste - Material determined to no longer have economic value or useful purpose.

49 Code of Federal Regulation - The regulation which controls the shipment of everything in any vehicle. There are seven volumes with over 1200 parts. Information in enclosure (1), paragraph 10 was gathered from the second volume, parts 178 to 199. Copies of any volume can be purchased from the Government Printing Office, commercial phone (202) 783-3238.

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